PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

KAWABE, YASUMASA, et al.

Docket No: Q54114

Appln. No.: 09/295,329

Group Art Unit: 1752

Confirmation No.: 7050

Examiner: Y. THORNTON

Filed: April 21, 1999

For: POSITIVE PHOTOSENSITIVE RESIN COMPOSITION

DECLARATION UNDER 37 C.F.R. §1.132

Commissioner for Patents
Washington, D.C. 20231

Sir:

I, Yasumasa Kawabe, declare and state that the present Declaration is submitted to correct an error in the Declaration Under 37 C.F.R. §1.132 executed by me on March 11, 2003. The present Declaration corrects the values defined for profile A and profile B which were submitted in the Declaration Under 37 C.F.R. §1.132 executed by me on March 11, 2003.

Additionally, the present Declaration includes a further explanation of the significance of the 5% difference in residual film rate.

I further declare and state:

I graduated from Shinshu University, Faculty of Engineering, Course of Synthetic Chemistry in March, 1980.

In April of 1980, I was employed by Kurabo Co., Ltd, and since that time have been engaged in the study of physical properties of polymers.

From September of 1983 to March of 1986, I studied synthesis of electroconductive polymers at the polymer Laboratory of Aichi Institute of Technology, Course of Applied Chemistry as a research student.

Since April of 1986, I have been employed by Fuji Photo Film Co., Ltd., and engaged in the study of photopolymers and photo-resists at the Yoshida-minami Laboratories of said Company.

THE 5% DIFFERENCE IN RESIDUAL FILM RATE

In the microphotoresist, the resist residual film rate is generally required to be 99% or more. Recently, in the production of semiconductor devices, there is very strong demand for higher residual film rates.

If the residual film rate of the resist is low, problems occur.

As to how the difference of several percentage in the residual film rate is important for resist by using pattern diagrams (representing cases with the residual film rate (film thickness remaining) of 99.3% in the present Examples and 94.6% in the Comparative Example), an impact brought about by the difference in the residual film rate appears conspicuously, for example, on a stepped board.

Attached Color Fig. 1 shows the state wherein resist was applied on the stepped board (before development). Attached Color Figs. 2 and 3 show the state after development.

Attached Color Fig. 2 relates to the present invention in which the residual film rate is high, and Attached Color Fig. 3 relates to the comparative example in which the residual film rate is low. In case of spin application of resist on the stepped board, the coating on a step section (B0) is generally thinner than that on the flat section (A0, C0) (A0>C0>B0). Similarly it becomes A1>C1>B1 and A2>C2>B2.

When the residual rate is high (for example, as shown by the formula (1)), B1 section can endure etching even if the film thickness is reduced a little at the time of etching. However, when the residual rate is low (for example, as shown by the formula (2)), the B section cannot endure etching if the film thickness reduces at the time of etching (Attached Color Fig. 4).

$$\frac{C1}{C0} \times 100 = 99.3\% \ldots\ldots\ldots \quad \text{Formula (1)}$$

$$\frac{C2}{C0} \times 100 = 94.6\% \ldots\ldots\ldots \quad \text{Formula (2)}$$

From such a point of view, the difference of the residual film rate of 4% to 5% has quite an important meaning.

If the coating film thickness of resist is thick in advance, the durability for etching at B section can be improved. However, the properties of resist such as resolution or DOF become

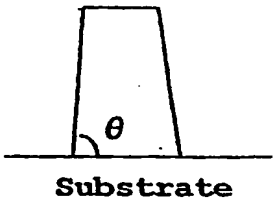
deteriorated generally. Therefore, the film thickness of resist is required to be as thin as possible. From such a point of view, a resist wherein the residual film rate is high is required.

In the actual semi-conductor device, the patterning on circuit board with steps is commonly practiced. Therefore, in order to carry out circuit board processing by etching with a high degree of accuracy, the residual film rate and the shape of resist are quite important, and the difference of the residual film rate in the comparative experiment data that have been already submitted (approximately 4% to 5%) is a difference with significant technological meaning and such a difference would have been considered to be an unexpected improvement to one skilled in the art.

THE EVALUATION OF THE PROFILE "A" AND "B"

The shape of the resist is shown in Figure 1 below, where the cross section of a 0.25 μm pattern is schematically shown.

Figure 1



When an angle (θ) between the substrate and the side-wall of the resist pattern is small, the profile (i.e., the shape of resist pattern) is a tapered shape (i.e., a T-shape). When the angle (θ) between the substrate and the sidewall is large, the profile is a rectangular shape.

Regarding the definition of profiles A and B, as noted by the Examiner, both the definitions of profile A and profile B should not contain the point of 85 degrees. The earlier textual description of the definition of profile A contained a clerical error. The definitions of profile A and profile B are as follows:

profile A: From not smaller than 86 degrees to not greater than 90 degrees;

And

profile B: Not greater than 85 degrees.

I submit that the profile definitions above are correct.

Accordingly, in the present invention, the tapered profile (i.e., the T-shape) (designated as "B" in the present specification) means that the angle (θ) between the substrate and the sidewall is up to 85°.

A rectangular profile (i.e., the rectangular shape) (designated as "A" in the present specification) means that the angle (θ) between the substrate and the sidewall is from not smaller than 86° to not greater than 90°.

Thus, in view of measurement of the line width for the resist, the angle (θ) between the substrate and the sidewall is most preferably from 88 to 89°.

The angle between the substrate and the sidewall for contrasting Profile "A" and "B" shown in Table A' of the previous declaration is shown below.

	Profile	Angle between Substrate and Sidewall
Example a	A	89
Example b	A	88
Comparative Example a'	B	85
Comparative Example b'	B	85

As shown by the samples of the present invention, achievement of both improvement of performance in the development defect and the realization of a rectangular profile, which have been extremely difficult to obtain, are unexpectedly realized by the combination of the present invention.

Also, the angle between the substrate and the sidewall of the examples according to the present invention is in the range of from 88 to 89°, which is ideal.

THE UNEXPECTED EFFECTS SHOWN IN PROFILE A AND PROFILE B

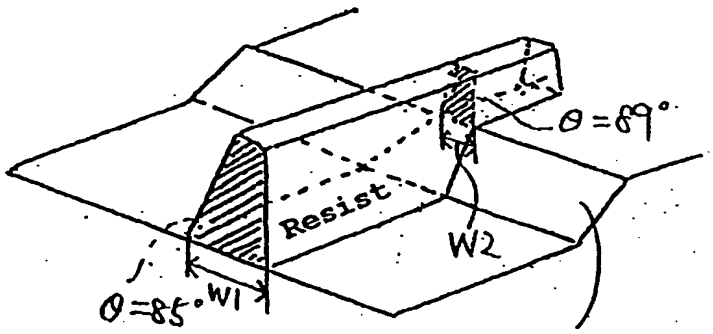
The change of the residual film rate and the shape of the resist by the addition of the claimed surfactant is an unexpected effect.

Previously, the residual film rate and the profile have been considered to be influenced by the polymer, the acid generator and the nitrogen-containing basic compound, which are the main constitutional components of the resist.

It is unknown in the art that the residual film rate and the profile would be extremely changed by addition of the surfactant. Therefore, such an effect is considered to be an unexpected effect.

THE EFFECT OF A DIFFERENCE BETWEEN PROFILE A AND PROFILE B

It is a disadvantage to have a variation in the Profile and to have a difference in the level. For example, when the angle (between the substrate and the sidewall) differs between 89° (which is within the range of the Profile A) and 85° (which is within the range of the Profile B) (i.e., a 4° difference), there is a large difference in the line width between an upper part and a lower part when there is a difference in level. See Figure 2 below.



Difference in level

Even if the angle between the substrate and the sidewall (θ) is slight, the difference in the line width (W1) and (W2) becomes large when there is a difference in level. As shown in Figure 2 W1>W2. That is, the difference between Profile A and Profile B becomes extremely large and the difference of the line width of the pattern becomes large. This is detrimental and is not preferable.

Also, when the angle between the substrate and the sidewall of the profile is small (as shown in Profile B, i.e., 85%), damage easily occurs upon the dry etching.

Accordingly, having a difference between Profile A (i.e., 89%) and Profile B (i.e., 85%) is an extremely large difference and the difference between Profile A and Profile B would be considered to be a significant and unexpected effect to one skilled in the art.

In Example a and Comparative Example a' of Table A and A', submitted on December 21, 2002, the type of the surfactant used is different. Similarly, Example b and Comparative Example b' differ in the type of the surfactant used.

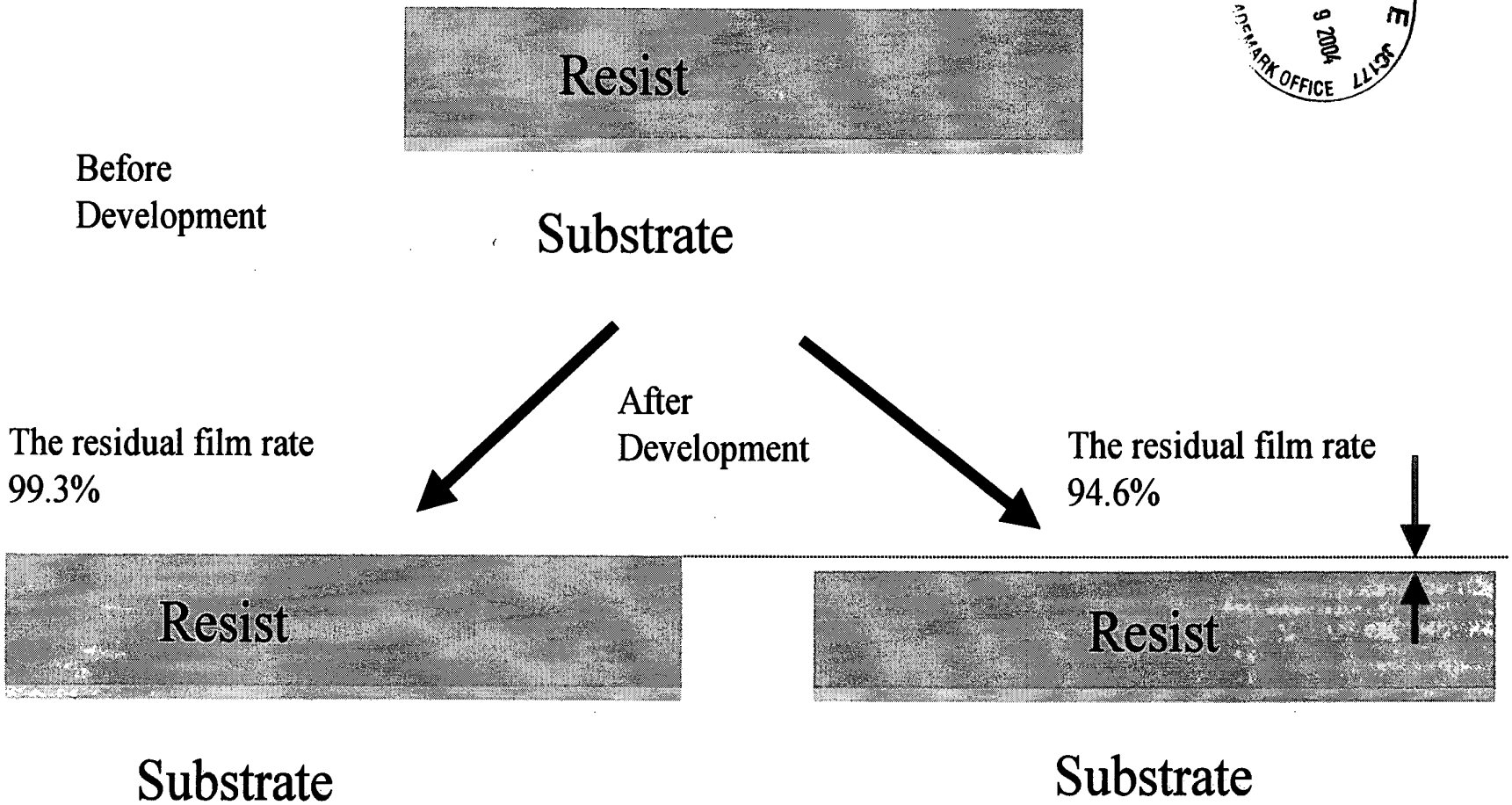
As is apparent from the results of Table A and A', the residual film rate and the profile are extremely changed by the difference in the surfactant used. That is, a specific and unexpected effect in the residual film and the profile are obtained by the use of the combination as claimed including the claimed type of surfactant.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both,

under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: _____

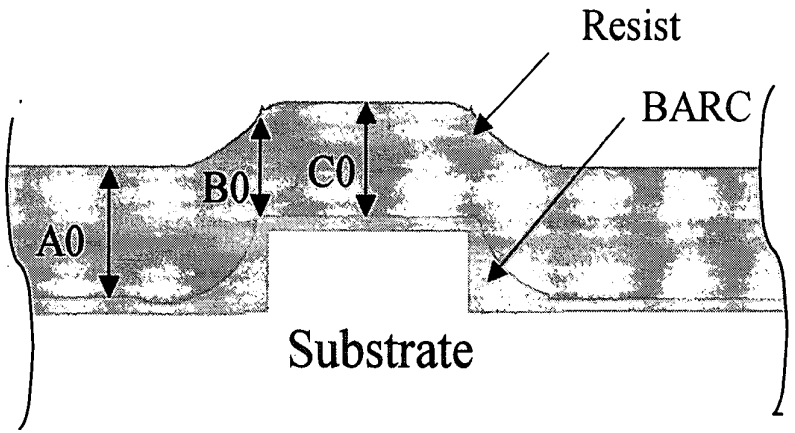
_____
Yasumasa Kawabe



The present examples (after development)

The Comparative Example (after development)

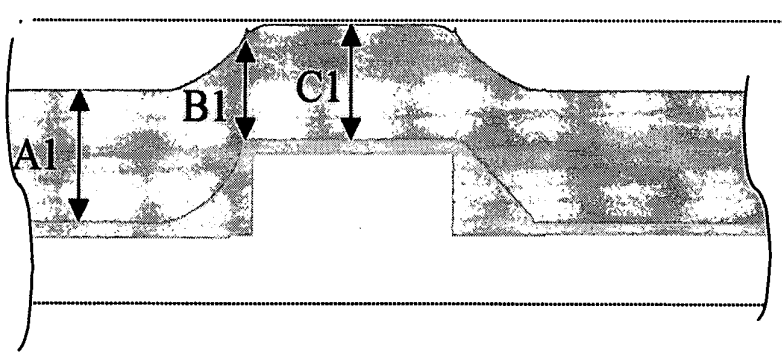
Difference of the residual film rate



Before Development

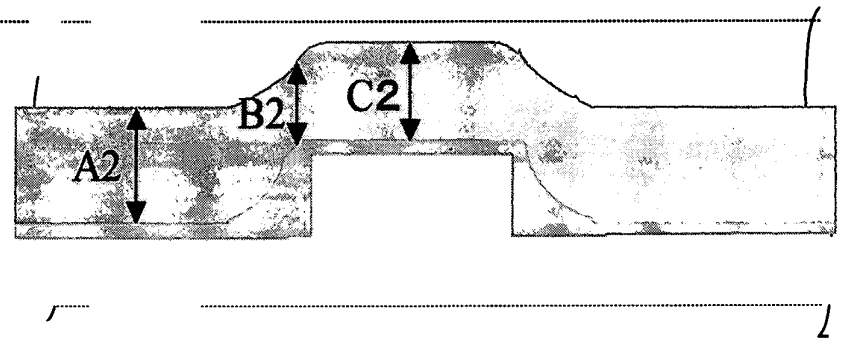
Figure-1

After Development



High Film Thickness Remaining

Figure-2



Low Film Thickness Remaining

Figure-3

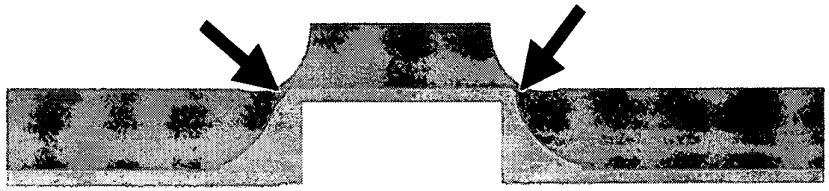


Figure.4 After Dry Etching